GRP International Journal of Business and Economics
Vol. 1. No.1 2012, PP. 24-49

ISSN 2048-8556[ONLINE]
www.gloresearch.org

Exchange rate volatility and trade: A Meta-Regression Analysis

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Abstract

Many empirical studies have been done to investigate whether trade is influenced by exchange rate volatility. Conventional wisdom is that increased exchange rate volatility inhibits the growth of foreign trade.This MRA extends by 10 studies and 100 observations Pugh's and Coric (2008) Meta regression. Now this MRA is updated with studies published to date (2012 year). Around 67 studies have investigated the effect of exchange rate variability and international trade resulting in 923 estimates. On average, exchange rate variability exerts negative effect on international trade. The conlcusion is that in the literature of exchange rate variability and trade there is presence of genuine empirical effect and not a presence for publication bias. The publication bias that appeared in the clustered robust model is perhaps due to the ten papers that were added to Pugh's and Coric MRA. They were not from the Econlit data base. Results are summarized in the following two tables.

Introduction

There are many debates among economists about the exchange rate's volatitly and trade. The main subject of our paper is to identify and present the positive and negative side of exchange rate regime to foreign trade by empirical investigation. Some analyses show that flexible exchange rate increases the level of exchange rate uncertainly and thus reduce incentives to trade. Proponents of fixed exchange rate ragime have long argued that the risks associated with exghange rate variability discounrage economic agents from trading across borders, especially when we thing abount small open countries. Despite this widespread view, the substantial empirical literature examining the link between exchange rate uncertainty and trade has not found a sonsistent relationship. Moreover, the debate on the implications of the choice of the exchange rate regime basically lacks a sound analytical foundation.[3]

On the other side, some research suggests an opposite direction of causality, where trade flows stabilize real exchange rate fluctuations, thus reducing real exchange rate volatility. These two different point of view among economists imply the existence of a standard

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*Received 10 April 2012; accepted 12 June 2012

[3] Baccheta, P. and E. vanWincoop (2000) "Does Exchange Rate Stability Increase Trade and Welfare?" American Economic Review, 90(5), pp.1093-1109.

identification problem, whether exchange rate volatility influence international trade or vice verse?[1]

In that context, we will summarize the main findings based on empirical research that have been done to investigate the relationship between the exchange rate regime (stability) and trade.[2] First, exchange rate stability is not necessarily associated with trade. In a simple benchmark model with only monetary shocks, the level of trade is the same under a float as under a fixed exchange rate regime when preferences are separable in consumption and leisure. In general, trade can be higher under either exchange rate regime, depending on preferences and on the monetary policy rules followed under both regimes. Second, there are severel examples where trade is higher under one regime, while welfare is higher under the other. And finaly, we can conlude that the exchange rate regime is important for trade and welfare, but there are many other aspect that we have to take in to account.

Literature survey

Many empirical studies have been done to investigate whether trade is influenced by exchange rate volatility. Conventional wisdom is that increased exchange rate volatility inhibits the growth of foreign trade. A detailed literature survey on the effects of exchange rate volatility on trade has been outlined in this section (see Table 1).This table is taken from Ilhan (2006). Several theoretical studies such as Ethier (1973); Clark (1973); Baron (1976); Cushman (1986); Peree and Steinherr (1989) have shown that an increase in exchange rate volatility will have adverse effects on the volume of international trade. Other theoretical studies have demonstrated that increased volatility can have ambiguous or positive effects on trade volume: for instance, Viaene and de Vries (1992), Franke (1991) and Sercu and Vanhulle (1992).

It is widely believed that increased exchange rate volatility inhibits the growth of foreign trade. Negative effects of exchange rate uncertainty on trade flows are reported by many authors. Studies by Hooper and Kohlhagen (1978), Gotur (1985), Bailey et al. (1986, 1987) McKenzie (1998), Aristotelous (2001), Bailey and Tavlas (1988), Bahmani et al. (1993), and Gagnon (1993), among others, do not find any significant relationship between exchange-rate volatility and trade.

On the other hand, McKenzie and Brooks (1997), Klein (1990), Franke (1991), Giovannini (1988), Brada and Mendez (1988), Asseery and Peel (1991), Kasman and Kasman (2005), Sercu and Vanhulle (1992), Doyle (2001) and Bredin et al. (2003) have found positive effects of exchange rate volatility on trade. Overall, a larger number of studies appear to favour the conventional assumption that exchange rate volatility depresses the level of trade.In the next Table are summarized studies about the exchange rate variability and trade from 1978 onwards.

[1] Broda, C., Romalis, J., 2003. Identifying the relationship between Exchange Rate Volatility and Trade. Mimeo, Federal Reserve Bank of New York, November 2003

[2] Ibid.

Table 1 Exchange Rate Volatility and Trade: Literature Survey

Study	Sample Period	Nominal or real exchange rate used	Countries and Estimation technique used	Main Result
Alduar and Hilton (1984)	1974-S1Q	Nominal	OLS	Negative effect
Gotur (1985)	1974-82Q	Nominal	OLS	Little to no effect
Bailey. Taklas and Ulan (1986)	1973-84Q	Nominal	OLS	Not significant. mixed effects
Bailey. Tavlas and Ulan (1987)	1962-S5Q	Nomiana l &Real	OLS	Little to no effect
Bailey and Tavlas (1988)	1975-86Q	Nominal	OLS	Not significant
Belenger et al. (1988)	1976-87Q		INT	Significant and negative in 2 sectors
Brada and Mendez (1988)	1973-77A	Real	Cross section	Positive effect
De Grauwe and Verfaille (1988)	1975-SSA	Real	Cross section	Level of trade significantly

				stronger within EMS than outside EMS
Koray and	1961-	Real	VAR	Weak

Lastpares (1989)	85M			negative relationship
Mann (1989)	1977-87Q	Real	OLS	Few significant results
Peree and Steinherr (1989)	1960-85A	Nominal	OLS	Negative effect
Caballero and Corbo (1989)	--	Real	OLS and IVE	Significant and neg.ative effect
Lasaapes and Koray (1990)	1975-87Q	Real	VAR	Weak relationship
Medhora (1990)	1976-82A	Nominal	OLS	Not significant and positive effect
Asseery and Peel (1991)	1972-87Q	Real	OLS - ECM	Significant and positive except for UK
3mi — Smag.hi (1991)	1976-84Q	Nominal	OLS	Significant and neg.ative effect
Feenstra and Kendall (1991)	1975-88Q		G.A.RCH	Negative effect
Akhtar and Hilton (1991)	1974-S1Q	Nominal	OLS	Not significant. mixed effect
Kumar and	1974-	Nomin11	OLS	Not

Dhawan (1991)	850	& Real		significant and negative effect
Belenger et al.	1975-	Nominal	IVE. GIVE	Significant

(1992)	87Q			and negative effect
Kumar (1992)	1962-87A	Real	Standard deviation	Mixed results
Sanides *(1992 i*	*1973-86.4*	*Real*	*Cross section*	Negative effect
Gagnon(1993)	0	Real	Simulation analysis	Not significant
Frankel and Wei (1993)	1980-90A	Nominal & Real	OLS and WE	Small and negative in 1980. positive in 1990
Kroner and Lastpares(1993)	1973-90M	Nominal	GARCH-M	Significant. varied signs and magnitudes
C howdhury(1993)	197$. 90Q	Real	VAR	Significant negative effect
Caporale and Dorodian (1994)	1974-92M	Real	Joint estimation	Significant negative effect
McKenzie and Brooks (1997)	1973-92M	Nominal	OLS	Positive effect
McKenzie (1998)	1969-95Q		ARCH	Generally positive effect
Daly (1998)	1978-910	Real	---	Mixed results

				(overall likely have a positive correlation)

Hook and Boon (2000)	1985-97Q	Both	VAR	Negative effect on export
Aristotelotts (2001)	1989-99A	Real	Gravitiy model	No effect on export
Doganlar (2002)	1980-96Q	Real	EG Cointegration	Negative effect on export
Vergil (2002)	1990-2000Q	Real	Standard deviation	Negative effect on export
Das (2003)	1980-2001Q	Both	ADF. ECM. Cointegration	Significant negative effect on export
Baal: (2004)	1980-2002A	Real	OLS	Significant negative effect on export
Tenreyro (2004)	1970-97A	Nominal	Gravity model	Insignificant and no effect on trade
Clark. Tamilisa. and Wei (2004)	1975-2000A	Both	Gravity model	Negative and significant effect
Kasman .S.: Kasman (2005)	1982-200IQ	Real	Cointegration. ECM	Significant positive effect on export
Arize et al. (2005)	19[7]3-	Real	Cointegration.	Sig..nificant

	2004Q	Real	ECM GARCH-M	negative effect on export Positive
Hwang and Lee	1990-			

(2005)	2000M			effect on import and insignificant effect on export
Lee and Saucier (2005)	1936-200$Q	Nominal	ARCH-GARCH	Negative effect on tradd

Source : Ilhan ,(2006)

Overall from this table can be discussed that a large number fo studies appear to favor conventional wisdom that exchange rate volatility exerts negative effect on trade. In the next section we will outline the model specification and explain meta regression techniques as well present the empirical results.

Model Specification

Following, Jarrell and Stanley (1989), and considering Stanley (2001), and recommendations from Pugh and Coric (2008), about the degrees of freedom, the MRA model has the following functional form [3]:

$$tstat(erves)_j = \text{int} + \sqrt{DF_j} + \sum \sim_k merv_{jk} + u_j \qquad j = 1,2....L \quad k = 1,2....M$$

- $j = 1,.......346$ Indexes the regressions in the literature;
- $k = 1.........22$ indexes the moderator variables ;
- Int- intercept term
- DF_j – is the degrees of freedom of *j*-th regression
- - is the coefficient to be estimated and measures the relationship between the square root of degrees of freedom and the effect size;
- $merv_{jk}$ – are moderator variables which reflect the main data and characteristics of j-th regression
- a_k – are *k* coefficients to be estimated , each of which measures the effect of a moderator variable on the effect size;
- u_j, e_i – are the usual residuals in the regression,
- L –represents the number of studies
- t_1 -is the usual t-statistics

Variable of interest

The variable of interest in this meta-regression is exchange rate variability. This ***exchange rate variability effect size*** (ERVES) is independent of the units in which variables in different studies are measured and, given the large sample, under the null of no genuine effect approximates the standard normal distribution (Stanley, 2005), which makes it suitable for the statistical analysis outlined in the following section.. Studies are compared, and results are combined. Meta-analysis usually is done if the author is not certain about the result from one particular study. And when these studies are heterogeneous, straightforward combination of

[3] In the following sections will be presented the final parsimonious model which will be tested by different econometric techniques

the test results may be too simplistic, and more sophisticated techniques should be used (Kulinskaya, Morgenthaler, Staudte, 2008).

Effect Size and controlling for degrees of freedom

After compiling the set of relevant studies a summary statistic of the effect size has to be chosen

- to combine and compare the effects size of the studies to find their mean value and test their significance
- and as the dependent variable of the MRA

Stanley and Jarrell (1989) recommended that, in economics, the *t-value* of regression is the natural effect size. The effect size approximates the standard normal distribution N~ (0, 1), under the null hypothesis of no effect. The t-statistics has no dimensionality, and it is standardized measure on the parameters of interest. Statistical theory predicts relationship between t-ratio and, the squared root of the degrees of freedom [4].The formula for the t-value on the estimated coefficient $\hat{\ }_i$ is as follows where the denominator, in the square brackets is the standard error of $\hat{\ }_i$:

$$t_{\hat{\ }_i} = \frac{\hat{\ }_i}{\dfrac{\left(\sqrt{\sum \hat{u}_i^{\,2}}\,\dfrac{1}{\sqrt{df}}\right)}{\sqrt{\sum (x-\bar{x})^2 \left(1-R_i^2\right)}}}$$

DF gives the difference between the number of observations and number of independent variables in the model. Positive or negative statistically significant association between the squared root of the degrees of freedom and the t-statistics is known as existence of the authentic empirical effect.

Earlier studies that employ different monetary indices, cannot be compared. Therefore the effect size is chosen to be a pure number to avoid that problem, for the variable of interest.

Moderator variables

MRA synthesizes the empirical literature by identifying important study characteristics or model specifications and reflecting those differences in $merv_{jk}$. The types of elements that make up the $merv_{jk}$ might include:

- Dummy variables which reflect whether potentially relevant independent variables have been omitted from or included in the primary study;

[4] According to Stanley (2005), to test for an authentic relationship the square root of degrees of freedom should be used instead degrees of freedom.

- Specification variables that account for differences in functional forms , types of regressions, and data definitions and sources;
- Sample size
- Selected characteristics of the authors of the primary literature;
- Measures of research or data quality;

Publication bias

Publication bias or, the "file drawer problem" is the consequence of choosing research papers for the statistical significance of their findings [(5)] (Stanley, 2007). Statistical significance is judged by whether, the t-ratio of the explanatory variable is higher, or exceeds 2 in absolute value (Card, Krueger, 2001). There is natural tendency of reviewers and editors to look more favourably on the studies with statistically significant results. Studies that find relatively small and "insignificant" results tend to remain, in the "file drawer" [(6)].
There are identified three sources of publication selection in economics:

- Researchers or editors maybe are, predisposed to accept papers consistent with the conventional view.
- Researchers may use the presence of conventionally expected results as a model selection test.
- And "statistically significant" results are treated more favourably.

Correcting for publication bias

Correcting this bias is impossible without making untestable assumptions [(7)].Bayesian methods for "correcting" publication bias introduced by Givens et al (1997), assumes prior distribution on the number of unpublished studies. As it is noted, direction, extent, and the impact of publication and related biases, are uncertain and may vary greatly depending on circumstances (Copas, Shi, 2000).The extreme view of the problem is that the journals are filled with, 5% of papers which show type I error, while the file drawers, are filled with the remaining 95% of the studies that show non-significant results ($p>0.5$) (Rosenthal, 1991). Sterling (1959) also argued that non-significant results are rarely published and therefore the published literature is full of type I errors (Hedges, Olkin, 1985).

Meta-regression analysis of the trade effect of exchange rate variability

Meta-analysis of the ERVES

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[5] Or, publication bias is a tendency to publish studies depending on the magnitude, direction and statistical significance of the results (McDaniel, Rothotein, Whetz, 2006).

[6] With meta-analyses, statistical methods can be employed to identify or accommodate these biases.

[7] And all of the methods for correcting the publication bias are based on some assumptions.

Central consideration of meta-analysis is to test the null hypothesis, that the effect sizes are distributed standard normal, N~ (0,1), under the null hypothesis of no effect. The null hypothesis is that the mean effect is zero[8]. The hypothesised, exchage rate variability and trade relationship will be rejected , if the average effect size (average t-statistics), is not significantly different from zero. The data set of this MRA, consists of **923** estimated output elasticises, from the collected 67 empirical studies.This data set it is made of Pugh and Coric(2008) meta regression on exchange rate variability and trade, but we updated it with 10 more studies (100) observations. The mean value of the t-statistic, on the coefficients on the output elasticity -1.27, with standard deviation of 3.79149[9]. Provisionaly here we conclude that there exists negative relationship between exchange rate variability and trade. This conclusion is confirmed, by the simple vote-counting procedure[10] The observed erves ranges from -64.577 to 20.702 , which suggests considerable varioation around mean. However, if the differences among observed ERVES are random sampling effects, then under the null the standard deviation of the ERVES distribution should be one ($\sigma^2_{ERVES} = 1$); otherwise, in the presence of systematic variation from the mean, the standard deviation exceeds one ($\sigma^2_{ERVES} > 1$).

Table 2 Vote counting procedure

	Negative effect	No effect	Positive effect	Not conclusive
1. Hooper & Kohlhagen	0	1	0	0
2. Abrams (1980)	1	0	0	0
3. Cushman (1983)	1	0	0	0
4. Akhtar & Hilton (1984)	1	0	0	0
5. IMF (1984)	0	0	0	1
6. Gotur (1985)	0	0	0	1
7. Chan & Wong (1985)	0	1	0	0
8. Kenen & Rodrik (1986)	1	0	0	0
9. Bailey, Tavlas & Ulan (1986)	0	1	0	0
10. Cushman (1986)	1	0	0	0
11. Bailey, Tavlas & Ulan (1987)	0	0	0	1
12. De Grauwe & Bellfroid (1987)	1	0	0	0
13. Thursby & Thursby (1987)	1	0	0	0
14. Cushman (1988)	1	0	0	0
15. De Grauwe (1988)	1	0	0	0
16. Pradhan (1988)	0	0	0	1
17. Anderson & Garcia (1989)	1	0	0	0
18. Perée and Steinherr (1989)	1	0	0	0
19. Klein (1990)	0	0	1	0
20. Medhora (1990)	0	1	0	0
21. Bini-Smaghi (1991)	1	0	0	0
22. Smit (1991)	0	1	0	0
23. Assery & Peel (1991)	0	0	1	0
24. Pozo (1992)	1	0	0	0
25. Savvides (1992)	1	0	0	0

[8] Josheski, Dushko, Infrastructure Investment and GDP Growth: A Meta-Regression Analysis (September 1, 2008)
[9] See Appendix 1
[10] Table 2 with studies and effects is given in the following page.

26. Grobar (1993)	1	0	0	0
27. Bahmani-Oskooee & Payesteh	1	0	0	0
28. Chowdbury (1993)	1	0	0	0
29. Kroner & Lastrapes (1993)	1	0	0	0
30. Qian & Varangis (1994)	0	0	0	1
31. Caporale & Doroodian (1994)	1	0	0	0
32. Arize (1995)	1	0	0	0
33. Holly (1995)	1	0	0	0
34. Stokman (1995)	1	0	0	0
35. Arize (1996a)	1	0	0	0
36. Arize (1996b)	1	0	0	0
37. Daly (1996)	0	0	0	0
38. Kiheung & WooRhee (1996)	0	0	1	0
39. McKenzie & Brooks (1997)	0	0	1	0
40. Arize (1997a)	1	0	0	0
41. Arize (1997b)	1	0	0	0
42.Arize(1998)	1	0	0	0
43.Arize&Shwiff(1998)	1	0	0	0
44. Hassan & Tufte (1998)	1	0	0	0
45.Mckenzie(1998)	0	0	0	1
46.Dell'ariccia(1999)	1	0	0	0
47.Lee(1999)	0	0	0	1
48. Arize, Osang & Slottje (2000)	1	0	0	0
49. Rose (2000)	1	0	0	0
50. Chou (2000)	1	0	0	0
51. Abbott, Darnell & Evans (2001)	0	1	0	0
52. Aristotelous (2001)	0	1	0	0
53. Doyle (2001)	0	0	0	0
54. Sauer & Bohara (2001)	0	0	0	1
55. Sekkat (2001)	0	1	0	0
56. Giorgioni & Thompson (2002)	1	0	0	0
57. Fountas & Aristotelous (2003)	0	0	1	0
58.ARIZE(1998)	1	0	0	0
59.Mahmood, Ehsanullah,Habib(2011)	0	0	0	1
60.Wesseh, Jr and Linlin Niu (2012)	1	0	0	0
61.Pickard(2003)	0	0	0	1
62.Vergil(1999)	1	0	0	0
63.Kandilov(2008)	1	0	0	0
64.Bakhromov(2011)	1	0	0	0
65.WangBarret(2007)	0	0	0	1
66.Tenreyro(2007)	0	0	0	1
67.Ngouana(2012)	0	0	1	0
Total	**39**	**8**	**6**	**12**

In the previous table we can see the summary of studies and the effects reported. Most of the studies find negative relationship between exchange rate variability and trade 39, 8 studies find no effect while 6 studies report positive effect between exchange rate variability and trade 12 studies are not cocnlusive about the relationship either positive or negative.

Independent varibales

We include in the MRA the squared root of the degrees of freedom to test for the existence of an authentic empirical effect (Stanley, 2005). To confirm the existence of an authentic empirical effect we need to confirm that a statistically significant relationship between the effect size (t-stat) and the squared root of the deegrees of freedom exists and that the relationship has the same sign as the estimated average effect size. In the presence of the squared root of the degrees of freedom, the intercept can be interpreted as a measure of the publication bias, and if it is significant it constitutes a rejection of the null of no publication bias. If we want to explain the varioations in the exchange rate variability effect size , we include moderator variables.Moderator variables are either 1 or 0 value. As the Pugh and Coric we include **bilater**(Billateral exchange rates) , and **sectalt**(sectoral trade flows), moderator variable for import demand (**import**) it is being constructed and export is a benchmark variable.Moderator variable (**realer)** it is being constructed (real exchange rate variability) and noiminal exchange rate is a benachmark. Also moderator variables for **dailyer**,**weeklyer**, **monther**,a**nnualer** for daily, weekly, monthly and annual frequency of exchange rate variability. Studies also differed over the ***choice of measure to proxy exchange rate uncertainty***. The most common measure, the standard deviation of either exchange rate changes or percentage changes, is used as the benchmark. However, we identified 13 alternative measures in the literature (MERV 1-13; see Appendix 2 for definitions).Moderator variables for **cross –**Cross section data , **pooled**-Panel data, **gravity**-Gravity model data, **lrcoint**-Cointegration, **errorcor**-error correction model data.This serve to know how the estimates are obtained. moderator variables were included for all studies that control for ***structural breaks*** (DOCKSTR - including dock strikes, oil shocks, changes in monetary regime and wars).

Descriptive statistics of the model

First of all most of the studies use data from floathing exchange rate period this variable **floper** (mean = **0.67382**), most of the studies are done for developed countries **dc** (mean=**0.68**). The variable for the effect size , exchange rate variability **erves** (mean=**-1.27306**) is our main variable of interest.Most studies use quarterly frequency of exchange rate variability **quarter** (mean=**0.442037**), also most of the studies use **realer real exchange rate variability** this variable mean=**0.543991**. Continuous variables are included for testing the authentic empirical effect in the MRA analysis following the recommendations of Pugh and Coric (2008), and Stanley (2008): the square root of the degrees of freedom (**sqrtdf**, mean=**16.24771**; sd=**26.44371**).Most estimates are obtained with panel methods,**pooled** variable (mean=**0.204936**)[11].

Results

The robustness of the results it is being taken into account by estimating the model with 4 estimation techniques namely: Robust OLS, Clustered Robust OLS, Weighted least squares (WLS), and clustered robust weighted least squares. Type I publication bias is directional and Type II publication bias that favors statistical significance regardless of the direction. Acrossthree estimates , except for the clustered robust OLS ,intercept is insiginificant which

[11] See Appendix 3 Descriptive statistics of the model

rejects the null hypothesis of publication bias[12].The coefficient on the squared root of the degrees of freedom is negative and significant and this supports the presence of genuine empirical effect.

Table 3 Model specification

dependent variable is effect size erves		robust OLS		clustered robust OLS		weighted least squares		WLS cluster robust	
		Coef.	t	Coef.	t	Coef.	t	Coef.	t
sqrtdf	Squared root of the degrees of freedom	-0.0475	-4.02	-0.0475	-2.77	-0.03204	-2.75	-0.03204	-1.47
fixper	Fixed ER period	-1.58868	-1.12	-1.58868	-0.97	-4.9558	-5.77	-4.9558	-1.56
floper	Floathing ER period	0.677103	1.6	0.677103	1.02	1.307307	3.16	1.307307	2.02
ldc	Least developed countres	-1.20466	-2.98	-1.20466	-2.37	-0.89725	-1.93	-0.89725	-1.95
us	USA	0.887143	2.89	0.887143	1.51	0.589007	1.4	0.589007	1.28
import	Import	-1.13771	-1.49	-1.13771	-1.35	-1.39234	-3.24	-1.39234	-1.79
sectalt	Sector level	-0.51355	-0.84	-0.51355	-0.64	0.102027	0.19	0.102027	0.11
dailyer	Daily ER variability	-2.44723	-1.03	-2.44723	-1.17	-4.78492	-2.3	-4.78492	-1.23
weaklyer	Weakly ER variability	-1.40415	-0.67	-1.40415	-0.91	-1.32967	-0.75	-1.32967	-0.46
monther	Monthly ER variability	-1.90671	-0.93	-1.90671	-1.23	-3.02091	-1.81	-3.02091	-0.95
quarter	Quarterly ER variability	-2.67886	-1.25	-2.67886	-1.65	-3.98164	-2.33	-3.98164	-1.12
annualer	Annualy ER variability	-4.22572	-2.21	-4.22572	-2.9	-3.7513	-2.07	-3.7513	-1.22
realer	Real ER variability	0.29986	1.01	0.29986	0.85	-0.1223	-0.3	-0.1223	-0.24
cross	Cross-section data	-0.1015	-0.19	-0.1015	-0.13	-0.21942	-0.28	-0.21942	-0.21
pooled	Panel data	-0.80391	-0.57	-0.80391	-0.46	-2.29203	-3.48	-2.29203	-0.97
sesonadj	Seasonaly adjusted data	-0.69999	-1.46	-0.69999	-0.99	0.630447	1.07	0.630447	1.1
errorcor	Error correction model	-0.5354	-1.04	-0.5354	-0.62	0.092995	0.2	0.092995	0.21
lrcoint	Cointegration analysis	-1.4216	-2.05	-1.4216	-1.6	-0.67766	-1.05	-0.67766	-0.59
dockstr	Structural effects	-0.02461	-0.04	-0.02461	-0.04	1.001405	2	1.001405	0.88
MERV 1= 1 if absolute values of ER percentage change		1.376068	2.59	1.376068	2.31	0.988401	1.23	0.988401	1.28
MERV2= 1 if average absolute values of ER percentage changes		-1.94153	-0.79	-1.94153	-0.8	-3.72734	-3.89	-3.72734	-0.97
MERV 3= 1 if absolute differences between previous forward and current spot rat		-2.70365	-2.81	-2.70365	-1.22	-2.62199	-2.45	-2.62199	-3.06
MERV 4= 1 if the moving standard deviation of ER changes or percentage changes		-0.09833	-0.31	-0.09833	-0.19	-0.11085	-0.22	-0.11085	-0.23
MERV 5= 1 if the standard deviation of ERs from an ER trend equation		1.827757	1.68	1.827757	1.42	4.573659	4.97	4.573659	2.04
MERV 6= 1 if the standard deviation of ERs from a first-order autoregressive equation		-0.13978	-0.18	-0.13978	-0.18	0.779148	0.69	0.779148	0.83
MERV 7= 1 if long-run uncertainty; Perée and Steinherr's (1989) V and U measures		0.760523	0.95	0.760523	0.69	0.674792	0.66	0.674792	0.79
MERV 8= 1 if squared residuals from an ARIMA model		-0.8977	-0.67	-0.8977	-0.39	-1.50554	-1.81	-1.50554	-1.4
MERV 9= 1 if conditional variance calculated by an ARCH or GARCH model		1.164038	3.16	1.164038	2.24	0.351167	0.64	0.351167	0.59

[12] In the Pugh and Coric meta regression there was no evidence of type I publication bias ,here with augmented sample for 10 studies in clustered robust OLS model there is evidence of Type I publication bias at 1% level fo significance.This maybe result from the sample of 10 studies which we add and are not part of Econlit

MERV 10= 1 if variance calculated by a LM (linear moment) model		1.351917	0.89	1.351917	0.64	1.280663	1.1	1.280663	0.82
MERV 11= 1 if the variance of the ER around its trend prediction (ln et = φ0 + φ1t + φ0 t2 +εt)		-1.8922	-2.07	-1.8922	-1.83	-1.5627	-1.11	-1.5627	-1.07
MERV 12= 1 if unanticipated changes in ERs (used by Savvides, 1992)		-0.24288	-0.19	-0.24288	-0.21	-1.24283	-0.84	-1.24283	-0.85
MERV 13= 1 if information contained in forward exchange rate concerning exchange rate expectations (used by Cushman, 1988)		0.948364	0.51	0.948364	0.38	3.151435	2.22	3.151435	1.11
_cons	Intercept	2.125416	1.07	2.125416	1.61	2.262174	1.36	2.262174	0.78
F-stat(32, 890)=	17.09			None		8.3		8.56	
R-squared	0.2407			0.2407		0.2298		0.2298	
Num.of observations	923								

In this MRA the studies that control for least developed countries (**ldc)**, fixed exchange rate period(**fixper)**, import (**import**), quarterly exchange rate variability (**quarter**), real variability diverges from nominal in longer periods this is supported by the significant and negative estimates on the annua exchange rate variability (**annualer**), and all of the modeling strategies cros-ssection data (**cross)**,panel data (**pooled),**error correction model **(errocor),**and cointegraion model **(lrcoint),** exert negative results. Dummy variable for structural breaks in time series (dockstr), in this MRA appear not to be significant. 7 measures of the exchange rate uncertainty used in the literature do not robustly influence the exchange rate variability effect size. Also as in Pugh and Coric MRA the negative coefficient on **annualer**,**ldc**,and **realer**, confirms that the exchange rate variability has an adverse effect on trade. Next are presented results on Type II publication bias.

Table 4 Type II publication bias

ABServes	Absolute value of the effect size	Coef.	t
sqrtdf	Squared root of the degrees of freedom	0.022802	2.09
fixper	Fixed ER period	0.843288	0.63
floper	Floathing ER period	-1.00232	-2.6
ldc	Least developed countres	0.474035	1.31
us	USA	-0.53026	-2.29
import	Import	0.339242	0.48
sectalt	Sector level	-0.80442	-1.46
dailyer	Daily ER variability	2.539618	1.21
weaklyer	Weakly ER variability	0.839861	0.46
monther	Monthly ER variability	1.243429	0.69
quarter	Quarterly ER variability	1.166528	0.6
annualer	Annualy ER variability	0.868214	0.52
realer	Real ER variability	-0.0309	-0.13
cross	Cross-section data	-0.18598	-0.43
pooled	Panel data	1.435453	1.09
sesonadj	Seasonaly adjusted data	0.171385	0.43
errorcor	Error correction model	-0.18751	-0.42
lrcoint	Cointegration analysis	0.670748	1.07
dockstr	Structural effects	-0.51433	-0.81
merv1	1 if absolute values of ER percentage change	-0.7666	-1.68
merv2	1 if average absolute values of ER percentage changes	3.591151	1.53
merv3	1 if absolute differences between previous forward and current spot rat	1.172268	1.35
merv4	1 if the moving standard deviation of ER changes or percentage changes	0.169814	0.7
merv5	1 if the standard deviation of ERs from an ER trend equation	0.485537	0.53
merv6	1 if the standard deviation of ERs from a first-order autoregressive equation	0.793093	1.05
merv7	1 if long-run uncertainty; Perée and Steinherr's (1989) V and U measures	-0.11331	-0.17
merv8	1 if squared residuals from an ARIMA model	3.25965	3.52
merv9	1 if conditional variance calculated by an ARCH or GARCH model	0.049136	0.17
merv10	1 if variance calculated by a LM (linear moment) model	-1.87414	-1.26

merv11	1 if the variance of the ER around its trend prediction (ln et = φ0 + φ1t + φ0 t2 +εt)	0.41302	0.52
merv12	1 if unanticipated changes in ERs (used by Savvides, 1992)	1.565604	1.44
merv13	1 if information contained in forward exchange rate concerning exchange rate expectations (used by Cushman, 1988)	-2.77359	-1.5
_cons	Intercept	1.085821	0.61

Non significant coefficient on the intercept and of a small size means that we can reject the null of indicates non presence of publication bias. The other three models are not reported but are available and exert same result. The simplest and most commonly used method to detect publication bias is an informal examination of a funnel plot.

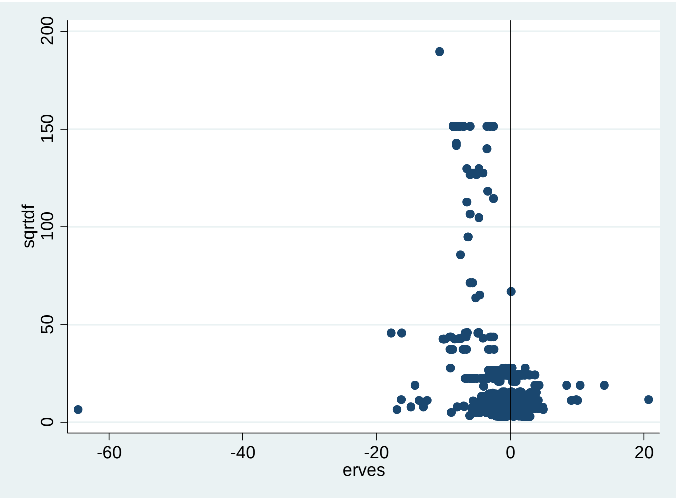


Figure Funnel Plot, t-stat(erves) on squared root of the degrees of freedom

In the absence of publication selection and regardless of the magnitude of the true effect, estimates will be symmetrically around the true effect. Because small sample studies with large standard errors and less precision are at the bottom of the graph , the plot will be more spread out at the bottom than it is at the top (Stanley,2005).

Egger's regression method

The Egger et al. regression asymmetry test and the regression asymmetry plot tend to suggest the presence of publication bias more frequently than the Begg approach. The Egger test detects funnel plot asymmetry by determining whether the intercept deviates significantly from zero in a regression of the standardized effect estimates against their precision (STATA 11 manual).

- The intercept value (A) = estimate of asymmetry of funnel plot
- Positive values (A > 0) indicate higher levels of effect size in studies with smaller sample sizes.
- Regression equation: SND = A + B x SE(d)-1. SND=standard normal deviate (effect, d divided by its standard error SE(d)); A =intercept and B=slope.

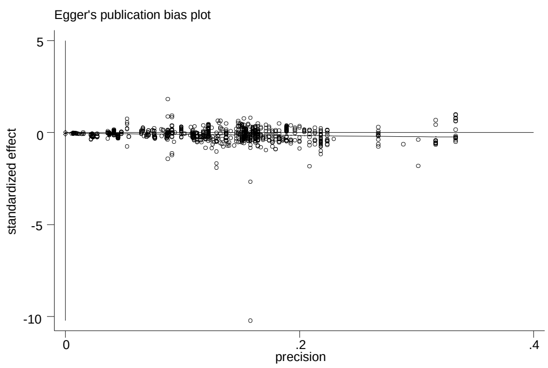
Asymmetry on the right of the graph (where studies with high standard error are plotted) may give evidence of publication bias.On the next Table 5 are presented egger's test results.

Table 5 Eggert's test

Egger's test			
Std_Eff	**Coef.**	**t**	**p-value**
slope	-0.635791	-2.88	0.004
bias	-0.030748	-0.97	0.333

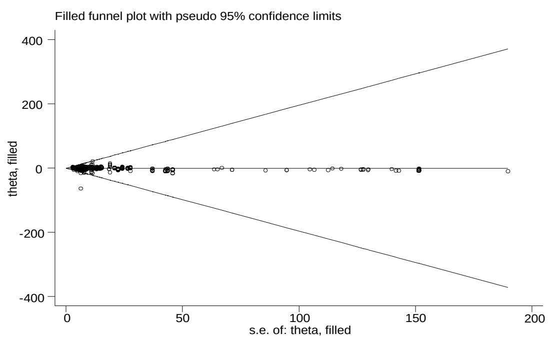
The intercept is negative and significant at all conventional levels of significance, which indicates assymetry to the left.the coefficient on the bias is insiginificant which rejects the existence of bias. Next it is presented eggert's publication bias plot which indicates that standardized effect is scattered on positive and negative side and the regression line is not very far from the intercept.

Graph Egger's publication bias plot



Egger's publication bias plot shows slight assymetry on the negative side.

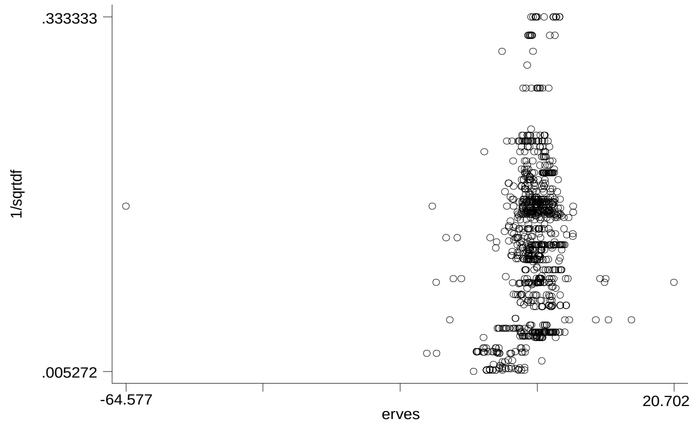
Next we present Funnel plot



Funnel plot did not show much heteroigeneity between studies.

On the next funnel effect size is plotted against the invesrse of the squared root of the of the degrees of freedom

Funnel plot effect size and invesrse of the squared root of the degrees of freedom



The funnel shows that effect size has a left assymetry when plotted against the squared root of the degrees of freedom.

Conclusion

Across three estimates, the intercept term (_cons) is not significantly different from zero at conventional levels, which rejects the null of publication bias.But in the clustered robust model the intercept is significant at 10% level fo significance Coefficient on the squared root of the degrees of freedom is negative and statistically significant at all levels of statistical significance except in the Cluster robust WLS model. The conlcusion is that in the literature of exchange rate variability and trade there is presence of genuine empirical effect and not a presence fo publoication bias. The publication bias that appeared in the clustered robust model is perhaps due to the ten papers that were added to Pugh's and Coric MRA.They were not from the Econlit data base. Results are summarized in the following two tables.

Findings on Type I publication bias: Dependent variable (effect size): t-statistics on the variable of interest in each study

Type I publication bias (t-stat as dependent variable)	sign on the coefficient on sqrtdf (squared root of the degrees of freedom) and significance			
	t-stat regressed on sqrtdf (model 1)			
squared root of the degrees of freedom (sqrtdf) +control variables	OLS	Cluster robust OLS	WLS	Cluster robust WLS
Sign on the squared root of the degrees of freedom (sqrtdf) and significance	-***	-***	-***	-
Sign on the constant and significance	+	+*	+	+

"- "- negative sign on the variable *- significant at 10 percent level of significance
"+"-positive sign on the variable **-significant at 5 percent level of significance

n.a.- not available ***- significant at 1 percent level of significance (all levels of significance)

Findings on Type I publication bias: Dependent variable (effect size): t-statistics on the variable of interest in each study

Testing type I publication bias	OLS		Cluster robust OLS		WLS		Cluster robust WLS	
	type I publication bias	authentic empirical effect	type I publication bias	authentic empirical effect	type I publication bias	No authentic empirical effect	type I publication bias	authentic empirical effect
Model 2 (t-stat regressed on the squared root of the degrees of freedom)	×	√	√	√	×	√	×	×

Findings on Type II publication bias: Dependent variable (effect size): absolute t-statistics on the variable of interest in each study

Testing type II publication bias	OLS	
Model 3 (absolute t-statistics regressed on the squared root fo the degrees fo freedom)	type II publication bias	authentic empirical effect
	×	√

√- There is evidence of Type II publication bias or authentic empirical effect

×- There is no evidence of Type I publication bias or authentic empirical effect

From the available regression on the Type II publication bias and the conclusions in the previous Table we can conlcude thata there iss absence of Type II publication bias but presence of authentic empirical effect in the literature between exchange rate variability and trade in this case negative. Next, **388** of **923** regressions report t-statistics **>+2** or **<-2**. Of which, **79** regressions report t-statistics **>+2,** and **309** regressions report t-statistic **<-2**.This shows that in this literature,Type II publication bias is not likely to be present.

The mean effect size is **(-1.273063)** [13], this suggests negative relationship between *exchange rate variability and international trade*.
Furthermore, this MRA suggests that exchange rate variability effects on trade are more intensive in least developed countries (***ldc)*** than in US economy [14].,where studies that control for US variable find more positive association between exchange rate variability and trade.

[13] See Appendix 1
[14] Coefficient on us-studies (***us***) variable is positive and statistically significant except in the WLS and cluster robust WLS,coefficient on the (***ldc***) is negative and significant.

Appendix 1

Meta-Analysis

H_0:AERVES=0 H_1:AERVES≠0	Appendix B: Testing • H_0: σ^2_{ERVES}=1 • H_1 : σ^2_{ERVES}>1
AERVES: Average exchange rate variability effect size	
$\text{t-stat} = \frac{\text{Average Erves}}{\pm_{ERVES}^{2}}$ Where $\pm^2_{ERVES} = \frac{\hat{\pm}_{ERVES}^{2}}{\sqrt{DF}}$ AERVES= -1.273063 σ^2_{ERVES}=3.79149; and DF=899 $t = \frac{-1.273063}{\frac{3.79149}{\sqrt{899}}} = -10.0674$ Non –zero t-statistic	Chi-sq test statistic $\left(¡^2\right) = (n-2)\frac{\hat{\pm}_{ACOOEL}}{\pm_{ACOOEL}}$ Where n=932; $\pm^2_{ERVES} = 3.79149$; $\pm_{ERVES}$ =1; Hence, $¡^2$ =3532.28 Excess Variation The two-tailed P value is less than 0.0001 By conventional criteria, this difference is considered to be extremely statistically significant. For practical purposes, there is zero probability of making a type one error by rejecting Ho.

Appendix 2

MERV1 = 1 if absolute values of ER percentage changes
MERV2 = 1 if average absolute values of ER percentage changes
MERV3 = 1 if absolute differences between previous forward and current spot rates
MERV4 = 1 if the moving standard deviation of ER changes or percentage changes
MERV5 = 1 if the standard deviation of ERs from an ER trend equation
MERV6 = 1 if the standard deviation of ERs from a first-order autoregressive equation
MERV7 = 1 if long-run uncertainty; Perée and Steinherr's (1989) V and U measures
MERV8 = 1 if squared residuals from an ARIMA model
MERV9 = 1 if conditional variance calculated by an ARCH or GARCH model
MERV10 = 1 if variance calculated by a LM (linear moment) model
MERV11 = 1 if the variance of the ER around its trend prediction (ln et = φ0 + φ1t + φ0 t2 +εt)
MERV12 = 1 if unanticipated changes in ERs (used by Savvides, 1992)
MERV13 = 1 if information contained in forward exchange rate concerning exchange rate expectations (used by Cushman, 1988)

Appendix 3

Descriptive statistics

Variable		Obs	Mean	Std. Dev.	Min	Max
result		932	466.5	269.1895	1	932
author	authors	932	37.95815	20.22631	1	68
weight	Weights	932	0.083691	0.318745	0.01852	9.25
df	Degrees of freedom	932	962.5075	3873.021	9	35984
fixper	Fixed ER regime	932	0.077253	0.267136	0	1
floper	Floathing ER regime	932	0.67382	0.469066	0	1
fixflo	Fixed float	932	0.277897	0.448203	0	1
ldc	Least developed countries	932	0.236052	0.424882	0	1
dc	Developed countries	932	0.688841	0.463216	0	1
us	US	932	0.219957	0.41444	0	1
import	Imports	932	0.182403	0.386384	0	1
export	Exports	932	0.805794	0.395801	0	1
dailyer	Daily ER variability	932	0.032189	0.176596	0	1
weaklyer	Weakly ER variability	932	0.064378	0.245556	0	1
monther	Monthly ER variability	932	0.299356	0.458222	0	1
quarter	Quarterly ER variability	923	0.442037	0.496898	0	1
annualer	Annualy ER variability	932	0.137339	0.34439	0	1
bilater	Billateral exchange rates	932	0.474249	0.499605	0	1
realer	Real exchaneg rate variability	932	0.543991	0.498328	0	1
nomer	Nominal exchange rate variability	932	0.419528	0.493747	0	1
cross	Crosssection data	932	0.096567	0.295525	0	1
pooled	Panel	932	0.204936	0.403871	0	1
gravity	Gravity model	932	0.122318	0.327828	0	1
lrcoint	Cointegration	932	0.06867	0.253027	0	1
errorcor	Error-correction model	932	0.081545	0.273817	0	1
lagtest	Lag test performed	932	0.560086	0.496643	0	1

dockstr	Structural effects	932	0.141631	0.348858	0	1
merv1	1 if absolute values of ER percentage changes ER percentage changes	932	0.079399	0.270506	0	1
merv2	1 if average absolute values of ER percentage changes	932	0.043991	0.205186	0	1
merv3	1 if absolute differences between previous forward and current spot rates	932	0.025751	0.158477	0	1
merv4	1 if the moving standard deviation of ER changes or percentage changes	932	0.29721	0.457275	0	1
merv5	1 if the standard deviation of ERs from an ER trend equation	932	0.06867	0.253027	0	1
merv6	1 if the standard deviation of ERs from a first-order autoregressive equation	932	0.032189	0.176596	0	1
merv7	1 if long-run uncertainty; Perée and Steinherr’s (1989) V and U measures	932	0.052575	0.223304	0	1
merv8	1 if squared residuals from an ARIMA model	932	0.01824	0.133891	0	1
merv9	1 if conditional variance calculated by an ARCH or GARCH model	932	0.138412	0.345517	0	1
merv10	= 1 if variance calculated by a LM (linear moment) model	932	0.022532	0.148486	0	1
merv11	= 1 if the variance of the ER around its trend prediction (ln et = φ0 + φ1t + φ0 t2 +εt)	932	0.01824	0.133891	0	1
merv12	= 1 if unanticipated changes in ERs (used by Savvides, 1992)	932	0.008584	0.092299	0	1
merv13	1 if information contained in forward exchange rate concerning exchange rate expectations (used by Cushman, 1988)	932	0.022532	0.148486	0	1
erves	Effects size(t-stats on exchange rate vaiability coefficient)	932	-1.27306	3.79149	-64.577	20.702
sqrtdf	Squared root of the degrees of freedom	932	16.24771	26.44371	31	89.6945

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